

## Patents (Global Analysis)

This report examines nicotine use in five countries: The United States, the United Kingdom, India, China, and Japan. It covers public opinion about nicotine in each country, the major players from academia and the commercial world in each country that influence public opinion, and new possibilities for using nicotine without smoking. It also includes a historical background analysis for the two years prior to the report.

This report will be updated quarterly and will emphasize changes and new information.

One of the most interesting methods of predicting future developments and learning about potential research implications in the field of nicotine science is tracking and following registered patents. Commercial companies, academic institutions, and private researchers who wish to preserve the rights to their research findings will register patents. While patents might be vague or quite complex, they still allow a peek into the current and future status of developments in the field.

We assessed patents related to nicotine that were registered by pharmaceutical companies, leading tobacco industry corporations, commercial companies, and research institutes. It is noteworthy to mention that many of the institutional patents are based on research that was at least partially backed by governmental grants. The totals for each sector are summarized (Table 5).

Sector	# of Patents
Tobacco Companies	31742
Other Commercial Businesses	27210
Universities and Research Centers	15516
Pharmaceutical and Biotech	338

Table 5: Patent numbers by sectors (June 2015-June 2020)

The vast majority of the patents registered by the tobacco industry deal with improvements to current devices, adding new features, and addressing consumer concerns. Many aim to reduce the effects of electronic cigarettes and heat-not-burn devices on the environment. For example, patents were registered for a mechanism that reduces gas emissions and one that reduces the odor and respiratory irritants of second-hand smoke. Other patents include a unique exhale filter

within the device that allows the user to exhale internally to make vaping indoors and in crowded locations more acceptable (1), reducing the side effects of vaping, and using e-liquids that may relieve coughing (2).

Researchers who are developing new ways to quit smoking have created devices that produce negative feedback when a person smokes or intends to smoke (aversion therapy)(3) and nicotine intake methods that don't use cigarettes, including buccal absorption (4) and the combination of nicotine with substances such as CBD (5). Both of these solutions lower the dose of nicotine that is ingested. Another effort is aimed at reducing the levels of nicotine in smoking/vaping and smokeless tobacco products by genomically editing tobacco plants (6) or by creating synthetic nicotine with higher purity levels and reduced residual compounds and carcinogens (7).

As we noted in the research section of this report, nicotine has medicinal value. It is being used to enhance cognitive function and memory loss and to treat the symptoms of schizophrenia, Parkinson's disease, Alzheimer's disease, and epilepsy. Patents for potential nicotine-based treatments have been registered by Merck, Novartis, Lundbeck and others. Most of these new treatments focus on modulating the activity of the  $\alpha 7$ -nACh and the  $\beta 2$ -nACh receptors (8,9). Smaller biotech companies have also registered patents that use nicotine to treat lung issues (10), dyskinesia (11), and even migraine headaches (12).

Patents filed by research institutes and universities center on pure basic science research that may not translate immediately into products that can be used by the public. Because there is no immediate commercial value, academic research is often funded by government grants and grants from independent medical institutes. Basic science research on nicotine includes how to modulate nicotinic receptors to prevent kidney disease (13), how to genetically modify tobacco plants to reduce their nicotine content and/or carcinogenic potential (14,15) and how to create tobacco plants that will grow more robustly and produce the same amount of nicotine from fewer plants (16,17).

It is noteworthy that the vast majority of these patents will not evolve into actual products because of financial and scientific limitations, but tracking them allows us to understand how the industrial, commercial, and scientific communities see the future of nicotine.

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